

Claims

What is claimed is:

1 1. A shift reactor (**16HT, 16LT**) for reducing the amount
2 of carbon monoxide in a process gas containing at least
3 carbon monoxide and water, using a water gas shift
4 reaction, the shift reactor having a reaction chamber
5 (**32**), the chamber having an inlet (**36**) for entry of the
6 process gas into the chamber, an outlet (**38**) downstream
7 of the inlet (**36**) for exit of effluent from the chamber
8 (**32**), and a catalyst bed (**34, 50**) located between the
9 inlet (**36**) and the outlet (**38**) for converting at least
10 a portion of the carbon monoxide and water in the
11 process gas into carbon dioxide and hydrogen, the
12 improvement comprising:

13 means (**40, 40A, 40B, 40C, 40D, 41A, 41B, 41C,**
14 **41D**) for adding oxygen to the process gas in, or prior
15 to, the reaction chamber (**32**) for causing a reaction in
16 the reaction chamber (**32**) to enhance conversion of the
17 carbon monoxide in the process gas.

1 2. The shift reactor (**16HT, 16LT**) of claim 1 wherein
2 the quantity of oxygen added to the process gas is less
3 than about 2.0 mol%.

1 3. The shift reactor (**16HT, 16LT**) of claim 2 wherein
2 the quantity of oxygen admitted to the reaction chamber
3 is about 0.2 mol%, or less.

1 4. The shift reactor (**16HT, 16LT**) of claim 1 wherein
2 the catalyst bed (**34, 50**) in the reaction chamber (**32**)
3 comprises one or more metals having a promoted support,
4 the metal being selected from the group consisting of
5 the noble metals and the group of non-noble metals
6 consisting of chromium, manganese, iron, cobalt, and

7 nickel, and the promoted support comprising at least a
8 metal oxide.

1 5. The shift reactor (**16HT, 16LT**) of claim **4** wherein
2 the catalyst bed (**34, 50**) comprises a precious metal
3 from the group of noble metals consisting of platinum,
4 palladium, rhodium, and gold, and the metal oxide of
5 the promoted support includes at least one of cerium
6 oxide (ceria) and zirconium oxide (zirconia).

1 6. The shift reactor (**16HT, 16LT**) of claim **1** wherein
2 the catalyst bed (**34, 50**) requires neither
3 prereduction, a shutdown purge, nor an inerting
4 atmosphere to operate.

1 7. The shift reactor (**16HT, 16LT**) of claim **6** wherein
2 the shift reactor is operatively connected in a fuel
3 processing subsystem (**14, 16HT, 16LT, 18**) for a fuel
4 cell (**12**).

1 8. The shift reactor (**16HT, 16LT**) of claim **4** wherein
2 the shift reactor (**16HT, 16LT**) includes a high
3 temperature stage (**16HT**) and a low temperature stage
4 (**16LT**), and said means (**40, 40A, 40B, 40C, 40D, 41A,**
5 **41B, 41C, 41D**) for adding oxygen to the process gas
6 introduces said oxygen to the process gas substantially
7 at said low temperature stage (**16LT**).

1 9. The shift reactor (**16HT, 16LT**) of claim **1** wherein
2 the addition of oxygen to the process gas causes an
3 oxidation reaction in the reaction chamber (**32**) for
4 converting a portion of carbon monoxide in the process
5 gas to carbon dioxide.

1 **10.** The method of reducing the amount of carbon
2 monoxide in a process fuel gas, comprising the steps
3 of:

4 a. placing a catalyst bed **(34, 50)** in a water gas
5 shift reactor **(16HT, 16LT);**

6 b. feeding **(36)** the process fuel gas into operative
7 proximity with the catalyst bed **(34, 50)** to convert at
8 least a portion of the carbon monoxide in the process
9 fuel gas into carbon dioxide via a water gas shift
10 reaction; and

11 c. supplying oxygen **(40, 40A, 40B, 40C, 40D, 41A,**
12 **41B, 41C, 41D)** to the process fuel gas near, or prior
13 to, the catalyst bed **(34, 50)** for further converting
14 carbon monoxide in the process fuel gas.

1 **11.** The method of claim **10** wherein the catalyst bed
2 **(34, 50)** is selected from one or more metals having a
3 promoted support, the metal being selected from the
4 group consisting of the noble metals and the group of
5 non-noble metals consisting of chromium, manganese,
6 iron, cobalt, and nickel, and the promoted support
7 comprising at least a metal oxide, and wherein the
8 quantity of oxygen added to the process fuel gas is
9 less than about 2.0 mol%.

1 **12.** The method of claim **11** wherein the quantity of
2 oxygen is about 0.2 mol%, or less.

1 **13.** The method of claim **11** wherein the step of
2 supplying oxygen **(40, 40A, 40B, 40C, 40D, 41A, 41B,**
3 **41C, 41D)** to the process fuel gas comprises varying
4 **(41A, 41B, 41C, 41D)** the quantity of oxygen supplied to
5 attain a desired response.

1 **14.** The method of claim **10** wherein the step of
2 supplying oxygen (**40, 40A, 40B, 40C, 40D, 41A, 41B,**
3 **41C, 41D**) to the process fuel gas near, or prior to,
4 the catalyst bed (**34, 50**) effects an oxidation reaction
5 for further converting carbon monoxide in the process
6 fuel gas to carbon dioxide